

EVALUATION OF ON-LINE CARBON-IN-ASH MEASUREMENT TECHNOLOGIES

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With the many environmental restrictions that are being placed upon utilities, unburned carbonaceous material is a major concern. Carbon level is an important consideration for combustion efficiency as well as ash marketing. Present methods for effectively monitoring carbon-in-ash are limited due to the time required for the collection and laboratory analysis of combustion product samples. Another problem associated with sampling is the difficulty assuring that the sample analyzed is representative of specific boiler parameters. If the sample is not representative, its analysis will not provide a true indication of the combustion conditions in the furnace. For example, the sample analyzed may not correspond to a specific load or excess oxygen range as desired. The presence of unburned carbon has been shown to be a function of coal quality, pulverizer product fineness and heat release rate. Boilers are designed to take these factors into consideration. However, the Clean Air Act amendments of 1992 drove many utilities to switch coal supplies and install low NO_x burners. Higher carbon-in-ash levels have been the result of these changes in coal quality and the staged combustion characteristics associated with low NO_x burners. The two major cost penalties associated with higher unburned carbon levels are direct fuel loss and loss of ash sales revenue. These cost penalties can amount to hundreds of thousands of dollars for a given plant.

Over the past ten years, several methods for the on-line determination and monitoring of the unburned carbon content of ash samples have been explored. Infrared, capacitance and microwave, including both extractive and non-extractive systems, are among the technologies that have been developed to aid in the on-line monitoring of unburned carbon content in ash. Several of the systems marketed to date include units from CAMRAC, Clyde-Sturtevant, Applied Synergistics, M&W Asketchnik, and Rupprecht & Patashnick, Co. Utilities can benefit from the use of on-line carbon-in-ash monitors by having the capability to optimize boiler performance, lower unit heat rate, diagnose developing problems with pulverizers, dampers and burners, and increase ash utilization through improved quality.

In an effort to better determine their applicability and capabilities, Southern Company has undertaken an evaluation of several of the commercial units mentioned above. Equipment evaluated to date includes:

CAM (Carbon-in-Ash Monitor) -- CAMRAC Corporation

CAM's operating principle is based on the ability of carbon particles to absorb microwave energy. A sample of fly ash is automatically extracted from the duct isokinetically and placed in a small collection cell. A microwave frequency of 2450 MHz is passed through the collection cell. Power absorbed by the

sample is determined as the difference between power into the cell and transmitted and reflected power. Carbon content is proportional to power absorbed.

SEKAM -- Clyde-Sturtevant Engineering

Ash is collected super-isokinetically from the flue gas stream using two probes positioned at the economizer outlet. The sample is deposited into a glass chamber between two capacitor plates. Sample capacitance is determined and is inversely proportional to carbon content of the ash sample

FOCUS (Furnace On-Line CombUstion System) -- Applied Synergistics

The FOCUS operating principle is based on the premise that unburned carbon exiting the furnace will be hotter than the surrounding gases and carbon-free ash. Therefore, the carbon-laden particles will emit higher levels of radiant energy in the infrared range. Infrared video cameras installed along the furnace wall will record these hotter particles as white spots. The number of traverses in the camera's field of vision are recorded and input into site-specific equations which predict LOI as a function of counts per minute and load.

Residual Carbon Analyzer -- Mark & Wedell Asketeknik

This instrument operates on the principle that carbon content is proportional to the reflectance of infrared light. Ash samples are collected isokinetically from the duct and placed in a glass cell. The sample is then exposed to a light whose reflectance is used by the system's processor to determine residual carbon content from a correlation curve.

The evaluation considered factors such as operational method, response time, instrument size, portability of control panel and sampling apparatus, sample size, accuracy, cost, and normal maintenance requirements. As part of the evaluation, the CAM, SEKAM and FOCUS systems were placed at Georgia Power Company's Plant Hammond Unit 4. CAM and M&W instruments were also placed at Alabama Power Company's Plant Gaston Unit 4. Accuracy of carbon measurement, availability, response time, and durability were some of the issues addressed. The presentation describes the results of the evaluation to date.